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[54] **ELECTRIC RIBBON CABLE AND CONNECTOR ASSEMBLY**

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[52] **U.S. Cl.** ..... **174/59**, 174/117 F, 339/99 R, 339/186 M, 339/198 R

[51] **Int. Cl.** **H01r 13/46**

[58] **Field of Search** ..... 174/59, 60, 117 F, 117 R; 339/96, 97 R, 97 P, 99 R, 198 R, 198 J, 184 R, 184 M, 186 R, 186 M, 185 R, 17 F

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[57] **ABSTRACT**

An electrical ribbon cable having a plurality of conductors positioned substantially within the same plane is mounted within a connector housing to a plurality of connecting terminals by contact screws having pointed ends for puncturing the insulation surrounding the ribbon cable to contact respective ones of the conductors. The flat surfaces of the ribbon cable include at least one longitudinal groove and a recess is formed in the connector housing conforming to the cross section of the ribbon cable and has at least one projection engaging with the longitudinal groove on the ribbon cable to predetermine the alignment of the conductors with the connecting terminals. The connector housing is provided with an insulating support forming the recess and a removable cover; the insulating support includes rib members and the cover has recesses aligned with the rib members so that the cover is mounted in only one predetermined position. The cover has passages through which external conductors are attached to the respective connecting terminals.

12 Claims, 5 Drawing Figures

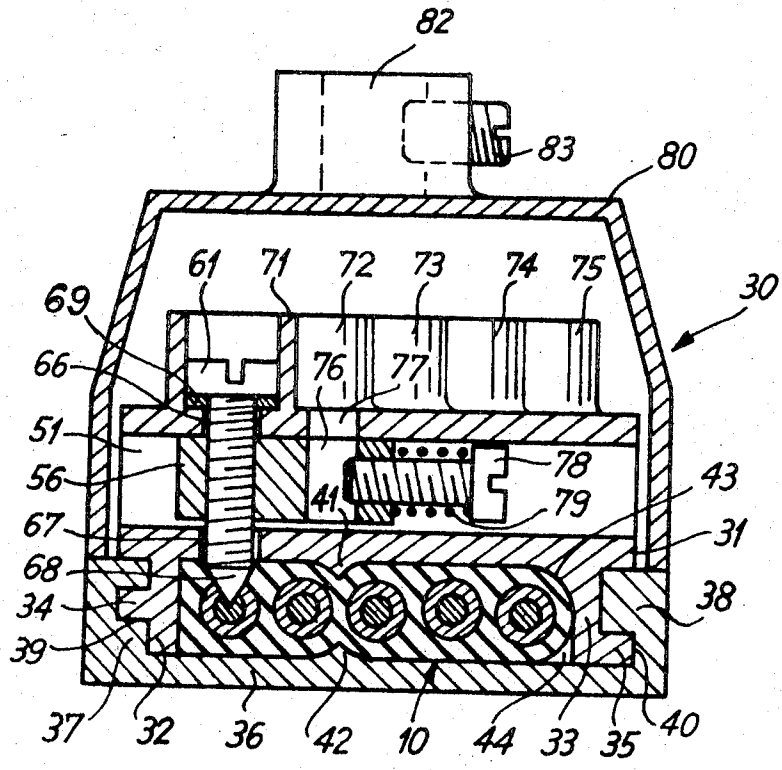


Fig. 1

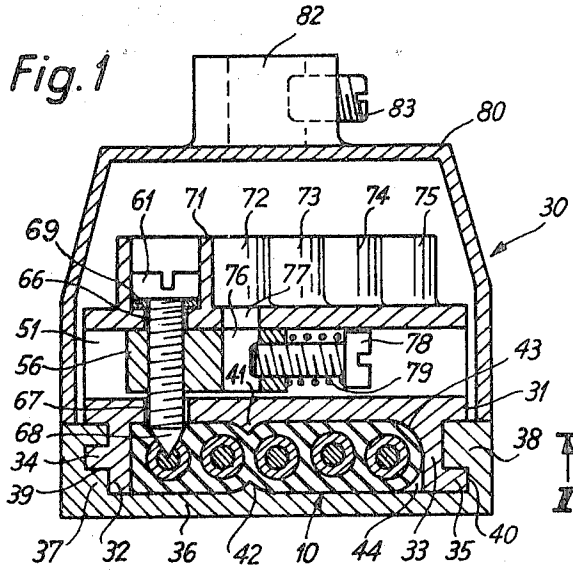


Fig. 2

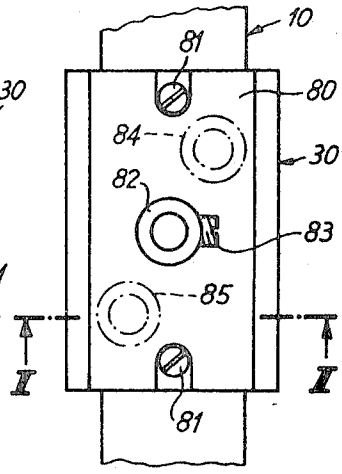


Fig. 4

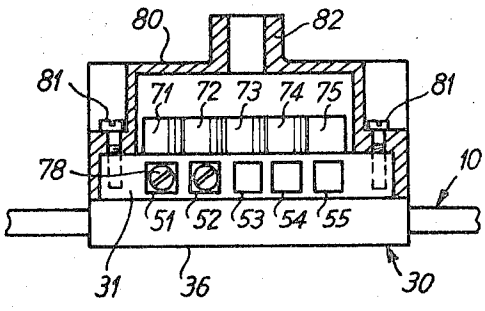


Fig. 3

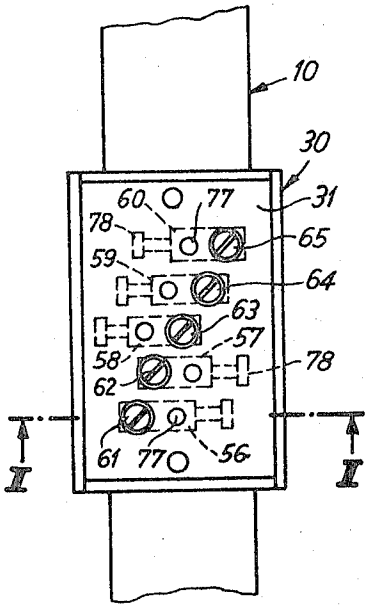
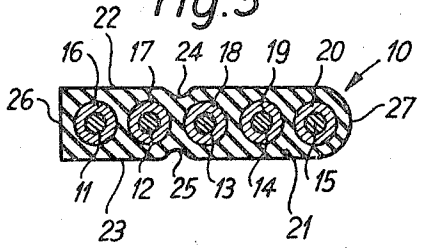


Fig. 5



ELECTRIC RIBBON CABLE AND CONNECTOR ASSEMBLY

The present invention relates to an electric ribbon cable having at least two parallel conductors in the same plane, and a connector associated therewith having a plurality of connecting terminals for branching lines corresponding to the number of conductors in the ribbon cable. The connecting terminals respectively carry contact screws with a tip for piercing the insulation of the ribbon cable to make contact with the respective conductors in the ribbon cable.

The problem with which the invention deals is the development of an electric ribbon cable and its associated connector that guarantees that connections will not be confused, i.e., that each contact screw of the connector can only be brought into contact with a predetermined conductor of the ribbon cable. This is important, e.g., in transmission of direct current, and in all cases in which one or more lines are grounded or connected with the neutral point of a three phase system.

This problem is solved in accordance with the invention in that the ribbon cable has at least one asymmetrically disposed longitudinal groove on a flat surface thereof, and in that the connector has a receiving recess for receiving a length of the ribbon cable, adapted to the cable cross section, and at least one projection that is designed for engagement in the longitudinal groove of the ribbon cable. Thus, the ribbon cable may only be inserted in the receiving recess of the connector in such a position that each contact screw can always be brought into contact with only one predetermined conductor of the ribbon cable.

Advantageously both flat sides of the ribbon are respectively provided with at least one asymmetrically disposed longitudinal groove so that the longitudinal grooves are opposite one another, in pairs. In this case the connector has at least one pair of projections that are intended for engagement in the longitudinal grooves on either side of the ribbon cable.

The ribbon cable may preferably have, for example, five adjacent conductors in the same plane, three of which are for connection to the phase conductors of a three phase system, one is for connection to the neutral conductor of the three phase system, and one is for connection to a protective ground. It is advantageous to have a pair of opposing longitudinal grooves in the ribbon cable at a point between two adjacent conductors, so that on one side of the groove there will be two conductors, advantageously the neutral and ground conductors, and the other side of the groove three conductors, advantageously the three phase conductors.

Further characteristics, details and advantages of preferred forms of embodiments of the ribbon cable and its associated connector according to the invention are apparent from the following description and in the attached drawings wherein:

FIG. 1 shows a cross section along line I—I in FIGS. 2 and 3, through a five-conductor ribbon cable and a connector mounted thereon;

FIG. 2 shows, on a smaller scale, a top view of FIG. 1;

FIG. 3 shows an analogous top view, with a protective cap removed from the connector;

FIG. 4 is a side view, seen from the right in FIGS. 2 and 3, where the protective cap is in longitudinal section; and

FIG. 5 shows, on a larger scale, a cross section through the five-conductor cable itself.

Ribbon cable 10 will first be described with reference to FIG. 5. Five electrically conductive lines 11, 12, 13, 14 and 15, advantageously stranded conductors, are respectively sheathed in tubular flexible insulating sheaths 16, 17, 18 19 and 20. The insulated conductors 11 to 15 are disposed adjacent to one another in the same plane, embedded in a flat shaped structure 21 made of rubberlike insulating material, which imparts an outer configuration to the ribbon cable. Ribbon cable 10 has two parallel flat sides 22 and 23, each provided with an asymmetrical, i.e., off center, longitudinal groove 24 and 25. Grooves 24 and 25 extend along the whole length of ribbon cable 10 and are disposed opposite each other at a location between two adjacent conductors 12 and 13, so that on one side of grooves 24 and 25 there are the two conductors 11 and 12, and on the other side of the grooves, the three remaining conductors 13, 14 and 15. One narrow side 26 of ribbon cable 10 is flat and at a right angle to flat sides 22 and 23. The other opposite narrow side 27 of the ribbon cable is curved.

Connector 30 associated with the above described ribbon cable 10 provides, according to FIGS. 1, 3 and 4, an insulating structure 31 having two parallel lengthwise arms 32 and 33 (FIG. 1) whose mutual separation is the same as the width of ribbon cable 10. The outsides of arms 32 and 33 that are turned away from each other each respectively have longitudinal ribs 34 and 35 that are disposed at different locations on the arms. Rib 34 is at about half the height of arm 32, while rib 35 is at the free end of arm 33. A substantially U-shaped cover has two legs 37 and 38 that engage arms 32 and 33 from the outside, each leg presenting a groove, 39 and 40 respectively, in which ribs 34 and 35 fit. Cover 36 is thrust over arms 32 and 33 in the lengthwise direction of ribs 34, 35 and grooves 39, 40 and thus is in releasable thrusting engagement with insulating structure 31. Cover 36 and insulating structure 31 together define a receiving recess 44 for a length of ribbon cable 10.

The cross section of receiving recess 44 essentially conforms to the cross section of ribbon cable 10. It has already been noted that the distance between arms 32 and 33 is the same as the width of ribbon cable 10. The height of receiving recess 44 corresponds to the thickness of ribbon cable 10. Insulating structure 31 further presents a riblike projection 41 that penetrates into recess 44 and is designed to engage in longitudinal groove 24 of ribbon cable 10. Analogously, cover 36 has a projection 42 that is intended to engage the other longitudinal groove 25 of ribbon cable 10. Since ribs 34, 35 and grooves 39, 40 on the two arms 32 and 33 or on the legs of cover 36 are different, it is impossible to incorrectly put cover 36 on insulating structure 31, so that projection 42 would not be opposite projection 41. Finally, on the inside of arm 33 there is a concave surface 43 adapted to the curved narrow side 27 of ribbon cable 10. It is obvious that with this configuration of recess 44, ribbon cable 10 can only have the position in recess 44 that is shown in FIG. 1, because the other way around with reversed positions of the flat, narrow side 26 and the curved, narrow side 27, there would not be enough room in recess 44 for the cable, and cover 36 could not be thrust down correctly over arms 32 and 34.

Above receiving recess 44, the insulating structure 31 presents a plurality of transverse cutouts 51, 52, 53, 54, 55 (FIGS. 1 and 4) corresponding to the number of conductors of ribbon cable 10, these cutouts being parallel to each other, and each containing a connecting terminal 56, 57, 58, 59, 60 (FIGS. 1 and 3). These terminals each have a contact screw 61, 62, 63, 64, 65 seated in a corresponding threaded hole in the terminal and passing through aligned holes 66 and 67 (FIG. 1) of insulating structure 31, so that the contact screw can be moved in, with its pointed end 68 into receiving recess 44 for cable 10. According to FIG. 3, connecting terminals 56 to 60 and their contact screws 61 to 65 are mutually staggered not only in the longitudinal direction but also in the transverse direction of ribbon cable 10 so that the axis of rotation of any of the contact screws intersects the longitudinal axis of an associated conductor of ribbon cable 10 at a right angle. Contact screws 61 to 65, for this reason, can be driven with point 68 through shaped structure 21 and insulating sheaths 16 to 20 of ribbon cable 10 in receiving recess 44 into conductors 11 to 15, as shown in FIG. 1, to effect contact between conductors 11 to 15 and the associated terminals 56 to 60. Spring washers 69 secure terminal screws 61 to 65 against unintentional release (FIG. 1). The head of each terminal screw 61 to 65 is surrounded by an insulating collar 71, 72, 73, 74, 75, disposed on the side of insulating structure 31 that is turned away from receiving recess 44 for ribbon cable 10. Advantageously the internal diameter of insulating collars 71 and 75 is so closely measured that the heads of contact screws 61 to 65 are in frictional contact with the insulating collars. In this way, there is additional security against undesired loosening of the terminal screws.

Connecting terminals 56 to 60 are each provided with a hole 76 that is parallel to the respective screws 61, 62, 63, 64, 65, aligned with hole 77 that leads to the outside in insulating structure 31, as shown in FIG. 1. These holes 76 and 77 serve to receive a branching line or conductor that can be clamped in hole 76 by means of a screw 78 (FIGS. 1, 3 and 4). Screw 78 is entirely within the transverse cutout in question (51, 52, 53, 54, 55) of insulating structure 31. A helical pressure spring 79 (FIG. 1) associated with screw 78 serves to secure it against unintentional loosening. In order to keep the size of connector 30 as small as possible in the direction transverse to that of cable 10 in recess 44, connecting terminals 56 to 60 are in part arranged opposite one another, as clearly shown in FIG. 3, so that screws 78 of terminals 56 and 57 can be manipulated from one narrow side of ribbon cable 10, and screws 78 of terminals 58, 59, 60 can be manipulated from the opposite narrow side of the cable.

Connector 30 is completed by a protective cap 80 that is advantageously made of insulating material, said cap being detachably mounted on insulating structure 31 by means of screws 81. Protective cap 80 engages the major part of insulating structure 31, so that cutouts 51 to 55 with connecting terminals 56 to 60 disposed therein, as well as the heads of screws 61 to 65 and the insulating collars 71 to 75 that surround them, are entirely within cap 80. A through passage 82 in cap 80 makes it possible to lead out the branching lines connected at terminals 56 to 60 from the connector 30. The branching lines may advantageously be conductors of a round cable that is introduced through passage 82. A set screw 83 makes it possible to clamp the jacket of the round cable in passage 82, to relieve the lines connected at terminals 56 to 60 from traction loads.

For certain applications it can be advantageous to provide cap 80 not only with a single through passage 82 but also with one or two additional passages 84 and 85 as indicated with dashed lines in FIG. 2, so that two or three round cables with outgoing conductors can be connected. Instead of simple passages there can be stuffing box passages.

The use and function of the described ribbon cable 10 and its associated connector 30 is as follows. Ribbon cable 10 can be mounted either hanging or lying, by means of straps, in a known way. At any place along ribbon cable 10, a connector 30 of the described type can be arranged. For this purpose, protective cap 80 and cover 36 are removed from insulating structure 31. Then contact screws 61 to 65 are loosened to the extent that their tips 68 no longer penetrate into the space between arms 32 and 33. Insulating structure 31 with its arms 32 and 33 is then laid straddling a length of ribbon cable 10 in such a way that the flat narrow side 26 of the ribbon cable is applied to the flat inner side of arm 32; and the curved narrow side 27 of the cable is applied to the concave surface 43 of the other arm 33; and projection 41 of the insulating structure 31 engages longitudinal groove 24 or 25 of ribbon cable 10.

With the insulating structure in the desired position, cover 36 is thrust on the opposite side of the ribbon cable over arms 32 and 33 of the insulating structure in such a way that ribs 34 and 35 of the arms come into engagement with grooves 39 and 40 of the cover, and projection 42 of the cover engages the free longitudinal groove 25 or 24 of the ribbon cable. In this way the receiving recess 44 for ribbon cable 10 is closed. Then contact screws 61 to 65 are tightened, whereby tips 68 of the screws penetrate the insulation of ribbon cable 10 from one of the flat sides and enter into contact with conductors 11 to 15 of the ribbon cable. The connector 30 is thereby fixed on ribbon cable 10. Because of the mutually adapted shaping of ribbon cable 10 and the configuration of receiving recess 44 of connector 30, terminal 56 can only be connected by means of screws 61 with conductor 11, terminal 57 only with conductor 12 by means of screw 62, terminal 58 only with conductor 13 by means of screw 63, terminal 59 only with conductor 14 by means of screw 64, and terminal 60 only with conductor 15 by means of screw 65. Any other insertion of ribbon cable 10 in receiving recess 44 of the connector and hence another association of conductors 11 to 15 are terminals 56 to 60 is effectively prevented by projections 41 and 42 as well as by the concave part 43 in recess 44. If therefore conductor 11 of the ribbon cable is connected with a protective ground, conductor 12 with the neutral conductor of a three phase system, and conductors 13, 14 and 15 of the ribbon cable with phase conductors R, S and T of the three phase system, terminals 56 and 60 of connector 30 always come into connection in the same predetermined sequence with ground, neutral conductor and phase conductors R, S and T, when the connector is applied to the ribbon cable. It is impossible, for instance, that terminals 56 and 57 could come into connection with conductors 14 and 15 that serve as phase conductors.

Next, a round cable (not illustrated) with a plurality of conductors is pulled through passage 82 of cap 80, and the individual conductors of the round cable are led into holes 77 and 76 respectively of insulating structure 31 or terminals 56 to 60, whereafter these conductors are clamped in the terminals by tightening respective screws 78. Cap 80 is then placed on insulating structure 31 and fastened by screws 81. Finally the sheath of the round cable is clamped by tightening set screw 83 in passage 82.

The round cable in question need not always have as many conductors as ribbon cable 10. If, as described, conductors 11 to 15 of the ribbon cable are connected to a protective ground, a neutral conductor and three phase conductors R, S and T of a three phase system, it is possible, for example, to connect branching conductors only to terminal 57 connected with the neutral conductor and to one of terminals 58, 59, 60 connected with the phase conductors. Possibly a third branch can be connected to terminal 56 that is connected to ground. The round cable in the former case needs only two conductors, and in the latter case only three conductors.

In the case of the variation illustrated in FIG. 2, with three passages 82, 84 and 85 in the cap 80, a two or three conductor round cable with branching conductors can be passed through each one of the passages 82, 84 and 85, whereby it will be preferred to connect one conductor of the three round cables with each of terminals 58, 59 and 60 connected with the three phase conductors. As a result, a symmetrical load of the three phase supply will be achieved and/or it will be possible to switch the round cables on or off, if desired, individually.

The connector 30 can be removed from ribbon cable 10 at any time and possibly reconnected with the cable at another location. After removal of the connector from the ribbon cable there remain in the latter the punctures made by contact screws 61 to 65, of course. Generally this is not harmful because in ordinary circumstances it is not possible to make contact with the current carrying conductors of the ribbon cable through the punctures.

The described ribbon cable 10 and a plurality of connectors 30 associated with it make it possible, for example, to install a series of lights, e.g., fluorescent lights, in a time-saving inexpensive way. Obviously there are countless other applications. The ribbon cable can of course present less than five, possibly only two conductors. In any case, however, by means of at least one asymmetrically disposed groove on at least one flat side of the ribbon cable and by means of a corresponding projection on the connector, which is designed for engagement in the longitudinal groove of the ribbon cable, it is ensured that insertion of the ribbon cable in the receiving recess made for it in the connector is possible in only one distinct position so that each contact screw of the connecting terminals can only be brought into contact with one predetermined conductor of the ribbon cable.

What we claim is:

1. An electrical ribbon cable and connector assembly comprising:

a plurality of individually insulated parallel conductors positioned substantially within the same plane of an electrical ribbon cable, said ribbon cable having an outer insulating body including two opposite flat surfaces, at least one of said flat surfaces being provided with at least one asymmetrically disposed longitudinal groove;

a connector housing;

a plurality of connecting terminals corresponding to the plurality of said conductors mounted within said connector housing;

a contact screw for each of said connecting terminals having a point for puncturing the insulation of said ribbon cable to contact a respective one of said conductors;

a recess formed in said connector housing conforming to the cross section of said ribbon cable, said recess including at least one projection for engaging with said at least one longitudinal groove; whereby the alignment of said contact screws with said plurality of conductors is determined by the engagement of said at least one projection with said at least one longitudinal groove.

2. An electrical ribbon cable and connector assembly as in claim 1 wherein both flat surfaces of said ribbon cable include at least one asymmetrically disposed longitudinal groove; said recess includes at least one pair of projections for engagement with said longitudinal grooves on each side of the ribbon cable.

3. An electrical ribbon cable and connector assembly as in claim 2 wherein one edge side of said ribbon cable is flat and the other edge side is curved and the edges of said recess opposing said one edge side and said other have conforming shapes.

4. An electrical ribbon cable and connector assembly as in claim 3 wherein said ribbon cable includes three conductors for connection to the respective phase conductors of a three phase system and a neutral conductor and a grounding conductor.

5. An electrical ribbon cable and connector assembly as in claim 4 wherein said three conductors, and said neutral and grounding conductors respectively are located on opposite sides of said pair of opposed longitudinal grooves.

6. An electrical ribbon cable and connector assembly as in claim 1 wherein each of said connecting terminals is mounted on the same side of said recess thereby enabling said contact screws to contact said conductors from one side of said ribbon cable.

7. An electrical ribbon cable and connector assembly as in claim 6 wherein said contact screws are staggered along the longitudinal axis of said connector.

8. An electrical ribbon cable and connector assembly as in claim 6 further comprising means at each of said connecting terminals for clamping a respective external conductor.

9. An electrical ribbon cable and connector assembly as in claim 6 wherein said housing includes a removable protective cap for covering said connecting terminals and including at least one passage for receiving an external conductor.

10. An electrical ribbon cable and connector assembly as in claim 6 wherein said housing further includes an insulating support for supporting said connecting terminals and a removable cover mounted to said insulating support.

11. An electrical ribbon cable and connector assembly as in claim **10** wherein said recess is formed by said insulating support and said cover and said insulating support and said cover each includes at least one projection for engaging with said at least one longitudinal groove, said insulating support includes rib members and said cover includes recesses aligned with said rib members whereby said cover is attached to said insulating support in only one predetermined position.

12. An electrical ribbon cable and connector assembly as in claim **10** wherein said insulating support includes individual transverse cutouts each supporting a respective connecting terminal.

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